Banisteria, Number 35, pages 47-52

Grasshoppers (Orthoptera: Acrididae) from the Virginia Barrier Islands

Timothy J. Arquette[1], John F. Barimo, and Richard R. Mills

Department of Biology
Virginia Commonwealth University
Richmond, Virginia 23284

ABSTRACT

Grasshopper populations from eight barrier islands off the coast of Virginia were studied over a 25-year period. A description of the species present and their abundance and primary habitats at different times of the year is given. Nine species of grasshoppers occurred on the islands: *Trimerotropis maritima*, *Psinidia fenestralis*, *Dissosteira carolina*, *Schistocerca alutacea*, *S. americana*, *Melanoplus differentialis*, *M. femurrubrum*, *M. bivittatus*, and *Arphia sulphurea*. Most common were the diet specialists *T. maritima* and *P. fenestralis*, which were found on or near dunes harboring their favored host plants. Another diet specialist was *S. alutacea*, which occurred exclusively on wax myrtle. *Melanoplus differentialis*, *M. femurrubrum*, and *M. bivittatus* are generalist feeders that were common in a variety of microhabitats. Grasshopper populations could be affected by changes in host plant abundance due to significant environmental impacts. The current study can serve as a baseline for future surveys of barrier island plant and animal communities and their ecological relationships.

Key words: Acrididae, grasshoppers, primary dunes, secondary dunes, *Spartina*, swale, wax myrtle.

INTRODUCTION

The Virginia barrier islands are among the most dynamic barrier systems along the Atlantic coast of North America, with extremely variable environmental conditions on temporal and spatial scales (Hayden et al., 1991). These sedimentary barrier islands are relatively flat, with elevations usually no more than 4 m above mean high tide (Barimo & Young, 2002). Consequently, they are subject to a high rate of disturbance from winds, storm surge, and overwash events. Barrier islands provide a variety of harsh environments for resident plants and animals (Bertness, 1999). Most severely affected is the sea-facing side of primary dunes, where exposure to sea spray requires that plants be salt tolerant. The land-facing or leeward side of the primary dunes is somewhat protected from wind and sea spray, providing a refuge for animals and allowing increased plant species diversity. American beach grass (*Ammophila breviligulata* Fern.), marsh hay (*Spartina patens* (Aiton) Muhl.), and seaside goldenrod (*Solidago* sp.) are some of the more common plants found leeward of primary dunes (Foust & Mills, 1992). Secondary dunes are typically smaller and farther inland than primary dunes, are less prone to wind and seawater disturbance, and harbor even more diverse plant and animal assemblages (Barimo, 1998). On the leeward side of secondary dunes, wax myrtle (*Morella cerifera* L.) thickets and swales also provide a suitable environment for insect herbivores (Foust & Mills, 1992; Barimo & Young, 2002).

Regressive (i.e., accreting) shorelines of barrier islands, such as those surveyed on Hog Island during this study, form a chronosequence in which relative age of a particular site increases with distance from the shoreline (Hayden et al., 1991). The chronosequence provides an opportunity to study the dynamics of primary succession in terrestrial ecosystems and can facilitate investigation into the underlying mechanisms of primary successional processes (Picket, 1989). Barrier island plant species are arranged in discrete zones parallel to the long dimension of the shoreline (Ehrenfeld, 1990; McCaffery & Dueser, 1990) and are shaped by successional processes (Ehrenfeld, 1990). Furthermore, insect herbivore populations also reflect these successional processes via their host plant preferences (Barimo & Young, 2002).

Grasshoppers are a conspicuous component of the insect fauna of the Virginia barrier islands and have

[1]Corresponding author: tja68@msstate.edu

been studied for many years, with a number of species newly documented (Barimo & Mills, 1991; Barimo & Young, 2002). There are no known publications documenting Eastern Shore grasshopper populations except by the present authors. The current communication reports on the grasshopper species and their habitats on eight of the Virginia barrier islands, ranging from Assateague Island in the north to Fisherman's Island at the mouth of the Chesapeake Bay (Fig. 1).

MATERIALS AND METHODS

Grasshopper species discussed in this paper were identified in part from individual research collections (Barimo & Mills, 1991) and especially from collections made on field trips by students in entomology and invertebrate zoology courses at Virginia Commonwealth University, Richmond, Virginia. Collections were conducted between the spring and late fall months. Class field trips were made to Assateague Island from 1978 to 1996, with several sites visited regularly. Students also collected grasshoppers at Fisherman's Island (1976-1998) and Hog Island (1990-1999), and occasional trips were made to Cedar, Parramore, Cobb, Wreck, and Smith Islands (1976-1999).

Qualitative collections were done primarily with sweep nets and by hand capture, with vegetation type noted. Field notebooks were obtained from each student and ecological data compiled and analyzed for 1976-1992 by Foust & Mills (1992). The current authors provided data from 1992 to 2000. Also, cross island transects were sampled on Hog Island during August and September 1997 to examine relative grasshopper abundance and species composition at discrete habitat types such as foredunes (primary and secondary), swale, thicket, and bayside marsh as well as 36- and 70-year-old dunes in the island's interior (Barimo, 1998).

RESULTS

About 1,000 specimens were collected over the 25-year period. Fifty percent of these came from Assateague Island and about 15% from Fisherman's Island. Another 15% came from Hog Island and the remainder from the other five islands. Approximately one-third of the total were *T. maritima* or *P. fenestralis* from the secondary dunes while another 20% were *M. femurrubrum* or *M. bivittatus*. *Arphia sulphurea* was found sporadically within the sand flats and made up only a small portion of the total.

A brief summary of observations on each island follows.

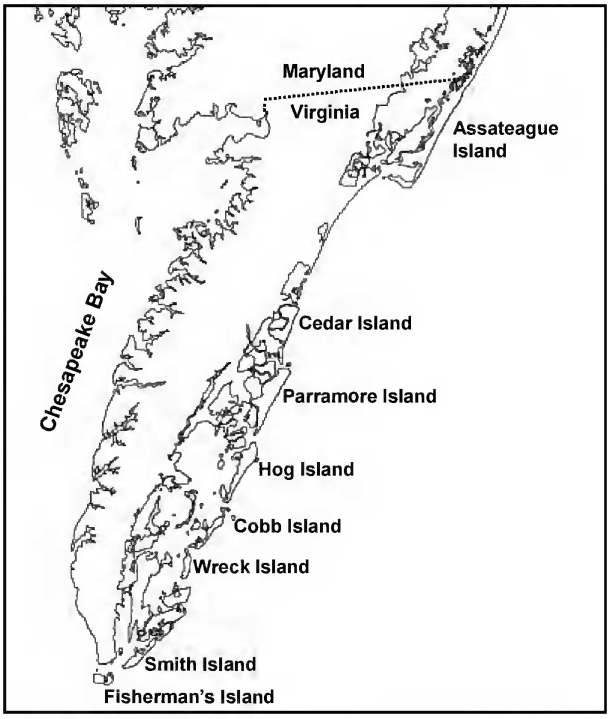

Fig. 1. Map of the Eastern Shore of Virginia showing barrier islands where grasshoppers were collected during this study.

ASSATEAGUE ISLAND

Grasshoppers collected at Assateague Island included the seaside locust *Trimerotropis maritima* (Harris), which was present on the secondary dunes and adjacent areas. No individuals of this species were collected within 20 m of the leeward side of primary dunes. The long-horned grasshopper *Psinidia fenestralis* (Serville) occupied pockets within the same areas. Both grasshoppers were found as first or second instar nymphs in early May, and as adults in late June or early July; some adults persisted until late November.

The Carolina locust *Dissosteira carolina* (Linnaeus) was common in grassy flats, sparse scrub pine areas, wax myrtle thickets, and occasionally on the secondary dunes or adjacent flats. A few nymphs were found in late June. Adults were common after early September until mid-October.

The leather-colored bird locust *Schistocerca alutacea* (Harris) was captured on wax myrtle only as adults in September through November. They were common from September to mid-October, but declined by late November. This species occurred only in localized areas containing wax myrtle, such as the isthmus leading into Tom's Cove.

The differential grasshopper *Melanoplus differentialis* (Thomas) and the red-legged grasshopper *Melanoplus femurrubrum* (De Geer) occurred from June to November. Nymphs of both species were generally present in sandy grassy areas on the extensive mid-island flats from mid-July until late September. Adults of *M. femurrubrum* occurred in large numbers in late August and early September. *Melanoplus differentialis* adults were first found in August, but complete maturity of the population did not occur until September. Unlike *M. femurrubrum* adults, which mainly stayed in the grassy habitat, most *M. differentialis* adults moved to wax myrtle thickets by September. *Melanoplus* mating was observed in October.

The spring yellow-winged locust *Arphia sulphurea* (Fabricius) was captured in small numbers on the flats in late June. This species did not appear to be well established, and was not collected during all years. Typically, *A. sulphurea* was an early summer resident that was not found after mid-July.

Cedar Island

Only two collections were made on Cedar Island, both in mid-July. *Trimerotropis maritima* was present on the mid-island secondary dunes, and a few small populations of *P. fenestralis* were seen. No grasshoppers were observed on the extensive low sandy areas to the south.

Parramore Island

A number of collections were made on the southern half of Parramore Island. Both *T. maritima* and *P. fenestralis* were typically found on the secondary dunes and continuing on sand flats to the west. *Dissosteira carolina* and *M. femurrubrum* also occurred on the flats, while adults of *M. differentialis* and *S. alutacea* were primarily found on wax myrtle in September-October. Collection dates and general habitats were similar to those on Assateague Island.

Hog Island

Extensive studies were conducted on Hog Island from 1991-1999, with most of the northern part of the island surveyed in detail by Barimo & Young (2002). *Trimerotropis maritima* occurred on primary dunes and *P. fenestralis* generally occurred on both primary and secondary dunes. Adults of both species were found from late June through October, with a few remaining into November. The two-striped grasshopper *Melanoplus bivittatus* (Say) occurred in the swale behind the dunes during July-August, but was replaced by *M. femurrubrum* in September-October. *Dissosteria carolina* occurred in the barren grassy areas in August through October. As on Assateague, both *M. differentialis* and *S. alutacea* were found as adults on wax myrtle in September, October, and November. *Melanoplus differentialis* adults were generally observed mating in mid-November. Limited numbers of *M. differentialis* adults were found in early spring 1997.

The cross-island survey in 1997 found a total of seven species with *T. maritima* and *P. fenestralis* occurring primarily in dunes as opposed to wet swales where *Melanoplus* congeners were found. Additionally, *D. carolina* and *S. alutacea* were noted on inland dunes together with *T. maritima* and *P. fenestralis*. The greatest species richness occurred on a 36-year-old dune, followed by the foredunes, and lastly by a 70-year-old dune located farther inland. *Melanoplus bivittatus*, *M. femurrubrum*, and *S. alutacea* were found in bayside marsh areas, with *M. bivittatus* seen actively feeding on smooth cordgrass (*Spartina alterniflora* Loisel.).

Cobb Island

Trips were made to the south end of Cobb Island in late July and mid-August. As for other islands, *T. maritima* and *P. fenestralis* were widely distributed on the secondary dunes. A few *D. carolina* adults were found near old buildings towards the inner or western side of the island. *Melanoplus femurrubrum* was quite common in the grass within the same area.

Detailed observations were also made on the north end of the island in mid-October. *Trimerotropis maritima*, *P. fenestralis*, and *M. femurrubrum* were still present, as was the American locust *Schistocerca americana* (Drury), which was found in taller and lusher grasses close to the western marsh edge near the northernmost point of the island. This was somewhat unexpected as only small populations of *S. americana* occurred on the mainland of the Virginia Eastern Shore.

Wreck Island

Collections were made twice at the north end of Wreck Island, both times in August. *Trimerotropis maritima* and *P. fenestralis* were present on the secondary dunes and a few *D. carolina* were also noted.

Smith Island

Several trips were made to Smith Island, but no comprehensive collections were performed.

Trimerotropis maritima and *P. fenestralis* were observed on the secondary dunes and in the wide sandy flats around the lighthouse. Both *M. femurrubrum* and *D. carolina* were common in the flats in September. *Melanoplus differentialis* was observed in adjacent taller grassy areas. This is the only instance that *M. differentialis* was not found on or within wax myrtle thickets.

FISHERMAN'S ISLAND

Many student field trips were made to Fisherman's Island. Both *T. maritima* and *P. fenestralis* were common on the secondary dunes, and were joined by *M. femurrubrum* on the extensive interior sandy areas. In September, *D. carolina* adults were numerous but neither *M. differentialis* nor *S. alutacea* were observed.

DISCUSSION

Patterns of distribution of *T. maritima* and *P. fenestralis*, both of the subfamily Oedipodinae, appeared fairly constant across the Virginia barrier islands. Both species were found routinely on the secondary dunes, which included the northernmost (Assateague) and southernmost (Fisherman's and Smith) islands. *Trimerotropis maritima* was also found on primary dunes at Hog Island, which was perhaps the harshest habitat on the barrier islands in terms of heat, desiccation, and exposure to sea spray. The distribution of *T. maritima* on the primary dunes of Hog Island may be the result of substantial beach erosion (Barimo, 1998) and suspected compression of the American beach grass (*A. breviligulata*) zone occurring at the time of the study. American beach grass was also determined to be the primary host plant for *T. maritima* (Barimo & Young, 2002).

Grasshoppers of the subfamily Melanoplinae routinely occurred at high abundance. *Melanoplus differentialis* was observed on about half of the islands. This is a ubiquitous species, found in nearly every county of Virginia, so it could be postulated with some certainty that this generalist feeder occurs on all of the barrier islands. *Melanoplus differentialis* was found almost exclusively on wax myrtle, in grassland swales enclosed within the wax myrtle thickets, and between dunefields. Individuals were observed eating wax myrtle leaves in October and November when most grasses had senesced. *Melanoplus differentialis* was very abundant as adults from late September until late November; on one occasion, adults were found early in the spring, apparently surviving a mild winter on Hog Island (Barimo & Young, 2002). *Melanoplus femurrubrum* was also very common, particularly in the swale and in grasses adjacent to wax myrtle thickets. This is consistent with its usual abundance in almost any grassy habitat. *Melanoplus bivittatus* occurred primarily on marsh hay (*Spartina patens*) in mid-summer, with populations declining by mid-August when *M. femurrubrum* adults appeared in great numbers.

Schistocerca alutacea was found exclusively on wax myrtle or within wax myrtle thickets. *Schistocerca americana* was found only on the north end of Cobb Island in mid-October. It inhabits the tall lush grass on the bay side. This species was not observed on other islands, although collections were made in its normal habitat. The chance that this grasshopper occurs throughout the Virginia barrier island system seems unlikely, although extensive future collections may reveal its occurrence on other islands.

Arphia sulphurea was collected only on Assateague Island and was not common at the locations where it was observed. Due to its requirement for a barren grassland habitat it may not be present on all barrier islands. The occurrence of this species appeared to be limited to the early summer months.

Results from several biogeographic assessments of the Acrididae occurring in Virginia and the eastern United States have been published. Fox (1917) collected Orthoptera in Virginia at sites that included beach and dune areas in Essex County and Virginia Beach. He found most of the same grasshoppers captured in this current study at those locations. Morse (1904) also collected in Virginia, albeit not close to the coast. He found that the non-coastal restricted Acrididae delineated in our current study were present in selected areas farther inland. Blatchley (1920) published a detailed monograph of the grasshoppers of northeastern America, and more recently an assessment has been published by Otte (1984). These publications indicate that all nine of the species studied should occur along the Virginia coast.

Grasshopper communities of the barrier islands vary to some extent by food availability. Grasshoppers collected on Hog Island had specific plant preferences with members of the Oedipodinae being specialists and members of the Melanoplinae tending to be generalist feeders (Barimo & Young, 1998). Furthermore, *M. differentialis* had a preference for wax myrtle, an actinorhizal shrub that fixes nitrogen in otherwise nutrient poor coastal soils (Wijnholds & Young, 2000). Wax myrtle appeared to support few other herbivorous species, suspected to be a result of the plant's waxy cuticle as well as aromatic secondary metabolites noted when leaves are bruised. However, wax myrtle likely offers *M. differentialis* proper dietary nutrients to offset the bioenergetic cost of metabolizing such compounds.

Table 1. Grasshopper species from eight barrier islands collected in four microhabitats. Abbreviations given are: Tm, *Trimerotropis maritima*; Pf, *Psinidia fenestralis*; Md, *Melanoplus differentialis*; Mf, *Melanoplus femurrubrum*; Mb, *Melanoplus bivittatus*; Dc, *Dissosteria carolina*; Sa, *Schistocerca alutacea*; As, *Arphia sulphurea*.

Microhabitat	Assateague	Cedar	Parramore	Hog	Cobb	Wreck	Smith	Fisherman's
Foredune				Tm				
Swale	Tm, Pf, Dc, Md, Mf, As		Tm, Pf, Mf, Dc	Mb, Md, Mf	Mf		Md, Mf, Dc	Tm, Pf, Mf
Secondary Dune	Tm, Pf, Dc	Tm, Pf	Tm, Pf	Tm, Pf, Mb, Mf, Dc, Sa	Tm, Pf	Tm, Pf	Tm, Pf	Tm, Pf
Wax Myrtle Thicket	Dc, Md, Sa		Md, Sa	Md, Sa				Md, Sa

Barrier island geomorphology is continually shaped by erosional processes and sediment deposition, driven in large part by ocean currents (Bertness, 1999). Variances in ocean currents between the Virginia barrier islands result in different island erosion and accretion patterns, which is subsequently responsible for differences in plant communities between islands (Young et al., 2007). Differences in plant communities between islands could be a factor in varied grasshopper distributions (Table 1).

The current survey, along with extensive field and laboratory studies by Barimo (1998), provides the first comprehensive description of the habitats, food preferences, life cycle, and abundance of grasshoppers on the Virginia barrier islands. This study will contribute baseline information useful for future assessments of changes to barrier island plant and animal communities. For instance, periodic future surveys of barrier island grasshoppers could document changes in population distributions that differ from those described in the current study. Also, results from recent research at the Virginia Coast Reserve Long Term Ecological Research Project identifying changes in plant community structure on these same islands (Young et al., 2007; Knapp et al., 2008) could be compared with findings of the current study and future grasshopper surveys to describe changes in grasshopper species distributions through barrier island microhabitats.

Significant environmental impacts such as long-term climate shift and catastrophic storm damage would alter plant communities which in turn would have cascading effects on grasshopper populations. A decreased proportion of the most commonly observed grasshoppers from the current study, the diet specialists *T. maritima* and *P. fenestralis*, as compared to the generalist *Melanoplus* species, would be expected from habitat reduction due to environmental factors or encroachment of new plants into the grasshopper specialist's habitats.

ACKNOWLEDGEMENTS

We thank the staff of The Nature Conservancy and the Virginia Coast Reserve Long-Term Ecological Research laboratory, especially Jimmy Spitler and Randy Carlson who minimized logistical problems associated with fieldwork at the Virginia Coast Reserve. We thank Nancy Wright of the Olympic Coast National Marine Sanctuary for graphic support. We would also like to acknowledge the many ambitious students participating in entomology and invertebrate zoology courses at Virginia Commonwealth University from 1976 to 2000.

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